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ENVIRONMENTAL SURVEILLANCE FOR PROJECT GASBUGGY PRODUCTION TEST PHASE

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by

Environmental Surveillance
Southwestern Radiological Health Laboratory

U. S. Department of Health, Education, and Welfare
Public Health Service
Environmental Health Service

June 1970

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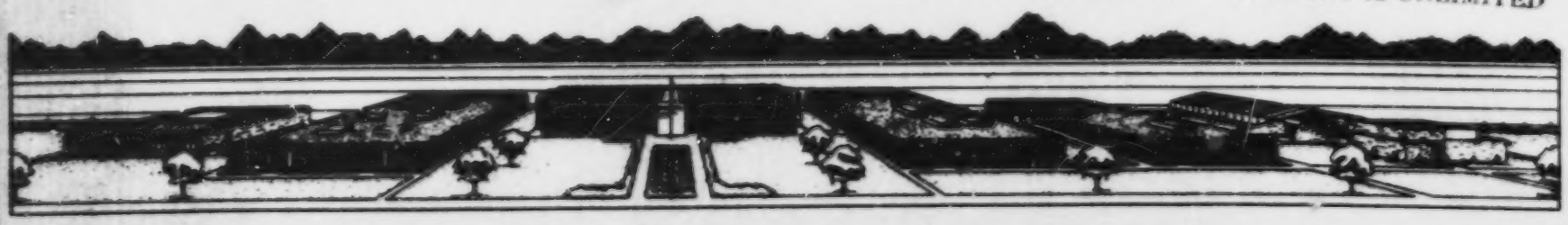

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SWRHL-100r

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by

Environmental Surveillance
Southwestern Radiological Health Laboratory

U. S. Department of Health, Education, and Welfare
Public Health Service
Environmental Health Service
Environmental Control Administration
Bureau of Radiological Health

June 1970

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ABSTRACT

Production testing of the Gasbuggy Emplacement Re-entry well took place from November 4, 1968, to November 14, 1969. The Southwestern Radiological Health Laboratory of the Bureau of Radiological Health (BRH) conducted a program of radiological monitoring and environmental sampling to document levels of airborne and deposited radioactivity released to the off-site area during this period.

Tritium was chosen as the nuclide of prime interest because of its biological significance relative to other isotopes expected, retention in the environment, and relative ease of collection and analysis. Samples were also analyzed for any other isotopes they might contain. Collection of environmental samples (atmospheric moisture, snow, vegetation, and soil) were made every one or two months. Airborne cryogenic samples were collected during September and October 1969.

Tritium, carbon-14, and krypton-85 were detected. The highest levels of tritium activity were found in the November 1968 samples. Activity levels dropped to background by July 1969, then rose slightly in September and October. Maximum carbon-14 levels were three times normal background. Low levels of krypton-85 were detected in aerial cryogenic samples in October 1969.

None of the environmental surveillance networks operated by the BRH showed any evidence of activity beyond the 10-mile Gasbuggy surveillance area.

It was concluded from the results of this surveillance that production testing of the Gasbuggy re-entry well did not create radioactivity levels in the environment which approached any appreciable fraction of the radiation protection guides.

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ENVIRONMENTAL SURVEILLANCE FOR PROJECT GASBUGGY PRODUCTION TEST PHASE

INTRODUCTION

Operating under a Memorandum of Understanding with the Atomic Energy Commission, the Southwestern Radiological Health Laboratory (SWRHL) conducted a program of radiological monitoring and environmental sampling to document levels of airborne and deposited radioactivity released to the off-site area surrounding the Gasbuggy site in New Mexico. This program was a continuation of previous surveillance by SWRHL for Project Gasbuggy which included surveillance for the Gasbuggy detonation[1] and subsequent Gasbuggy Emplacement Re-entry (GB-ER)[2] and the GB-2 Re-entry Phase I program[3,4]. This report covers the GB-ER production test phase flaring program which took place from November 4, 1968, to November 14, 1969.

FLARING PROGRAM

Post-shot production tests were designed to determine the rate of gas flow from the reservoir to the chimney under essentially stabilized conditions. By maintaining chimney pressure constant, the rate of production measured at the surface is equal to the rate of influx into the chimney. A series of three 30-day production tests were run on GB-ER, each at successively lower (and constant) chimney pressure, followed by a 7-month production period at a still lower pressure.

The natural gas produced in these tests was disposed of by burning (flaring) at the top of a ten-meter discharge stack. An in-line monitor was used by Eberline Instrument Corporation (EIC)* to measure the concentrations of tritium (^{3}H) and krypton (^{85}Kr) in the natural gas flowing to the flaring stack. Lower limits of detection for this monitor were 10 pCi of ^{3}H per ml of gas and 0.1 pCi of ^{85}Kr per ml of gas.

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*Eberline Instrument Corporation provided on-site radiological safety.

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Water vapor, containing tritiated water, was separated from the natural gas during production. This water was collected, then at a later date it was vaporized and injected into the natural gas at the flaring stack for disposal. Details are given in EIC reports.

SURVEILLANCE PROGRAM

Because of physical trapping of particulate forms of radioactivity in the cavity, only gaseous radioactive contaminants were expected to be present in any measureable concentrations in the natural gas from Gasbuggy. On the basis of the relative concentrations of the gaseous nuclides expected, and subsequently found, in the natural gas it was determined that only ^{3}H and ^{85}Kr might have any public health significance. It was concluded from this and from the allowable airborne concentrations that the public health significance of these two nuclides in air would be approximately equal. Tritium would be the only nuclide of concern in other environmental samples since krypton would not accumulate in them. Because of these considerations, the desirability of using the same indicator in all environmental media, and the relative ease of collection and analysis of ^{3}H, it was chosen as the nuclide of prime interest in the surveillance program.

Combustion of methane produces H_2O and CO_2. It was assumed that after flaring, the major fraction of ^{3}H existed as tritiated water in the vapor state and any ^{14}C was present as CO_2.

The permanent population surrounding the Gasbuggy site is tabulated in Appendix A. The transient population within 15 miles of the flaring operations consists of: up to 1,200 hunters for a few weeks in October and November; up to 500 transients and pinon nut hunters in the summer and early fall; and about 10 cowboys and sheep herders through the summer months. The off-site population was taken into consideration in designing the surveillance program.

During the surveillance period environmental samples were collected from the off-site area every one or two months. Samples were collected

during most of the periods of maximum flow. The type of sample taken varied depending on the season and the availability of samples (e.g. snow following a storm). Air samples were collected during each trip. Vegetation and soil samples were collected three times. Snow samples were collected twice. SWRHL aircraft were used to collect aerial samples simultaneously with ground sample collection during the September and October 1969 collections.

EQUIPMENT AND PROCEDURES

Air sampling units containing molecular sieve were used. The systems were composed of glass fiber filters for collection of particulates, followed by a column of Linde 13x molecular sieve in the form of 1/16-inch pellets. Linde 13x molecular sieve will reduce the dewpoint of air to lower than -80°C*. Laboratory and field tests indicated that 99+% of the water vapor was removed from the air sampled at the flow rates used. Since the molecular sieve co-adsorbs CO_2 with about the same efficiency, the samples were also analyzed for ^{14}C.

Before loading into the columns, the molecular sieve was degassed at SWRHL by heating to 350°C under a vacuum of less than 1 mm Hg pressure. All molecular sieve columns were double-bagged in plastic bags both before and after use to eliminate either uptake of additional moisture or loss of sample moisture.

Through March 1969 the air samples were collected on 4-inch-diameter by 14-inch-long columns of molecular sieve. The column held 4.5 pounds of molecular sieve. Air was drawn through this column at approximately four cfm using a positive-displacement pump driven by a propane fueled engine. Air sample volume was measured with a dry gas meter.

This collection system performed well, but its bulk and weight made it difficult to move into the rugged terrain at the Gasbuggy site, thus

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*According to the manufacturer, Union Carbide, Linde Division.

limiting the number of samples that could be obtained. For this reason a small, light-weight sampling system was developed and used from May 1969 to November 1969. This sampler used a two-inch-diameter by six-inch-long column holding one-half pound of molecular sieve. Air was drawn through this column at approximately 0.6 cfm using a self-contained battery-operated air sampler. The sampler has a built-in rotameter which was used to calculate the volume of air sampled. In October 1969 both types of molecular sieve samplers were used.

Ground-based air sampling systems were used to collect samples downwind of the flaring stack at various distances. An attempt was made on each trip to collect samples in the downwind area during daytime and in the downwind drainage area at night. During the sampling periods psychrometer readings were obtained so that an estimate could be made of the amount of water that should be collected on the molecular sieve. Barometric pressure at the time of sampling was obtained from the Farmington, New Mexico, airport and was used in air volume and moisture content calculations.

Aircraft samples were collected with cryogenic sampling equipment. A dry gas meter was used to measure the volume of air sampled. The cryogenic sampler consisted of a series of cold traps and a column of 5A molecular sieve immersed in a Dewar of liquid nitrogen held at 11 psi. Water vapor was frozen out in the cold traps and inert gases were collected on the molecular sieve. A glass fiber filter was used ahead of the sampler to collect particulate material.

Aerial samples were obtained by making passes along the plume trajectory at various altitudes. Samplers were operated only during the portion of time the aircraft was downwind of the stack to reduce sample dilution.

Snow samples were collected by scooping up the snow and putting it in a container.

The green, leafy part of vegetation (usually sagebrush) was collected and sealed in plastic bags. Three samples were collected at each location and bagged separately.

Soil samples were taken at the vegetation sampling sites. The top layer of soil was collected and sealed in a plastic bag.

SAMPLE ANALYSIS

All samples were returned to SWRHL for analysis. Each sample was logged in and given a laboratory number before analysis.

After molecular sieve samples were logged in, the molecular sieve material was transferred into a heating vessel where the water was elutriated at 350°C with a dry helium purge. Recovery of water from the adsorber exceeded 95%. This water was then re-distilled to eliminate possible interference by other contaminants. Tritium concentration was determined by liquid scintillation spectrometry. Five ml of the recovered water, five ml of a standard (for counting efficiency), and five ml of tritium-free water (for instrument background) were each diluted with 20 ml of a dark-adapted scintillation cocktail. The sample, standard, and background mixtures were each counted for 100 minutes in a liquid scintillation spectrometer optimized for tritium.[5]

The minimum detectable concentration (MDC) of ^{3}H is 0.4 pCi/ml of H_2O at the 95% confidence level, based on a 100-minute count and 5 mls of water. When the absolute humidity was low it was not possible to collect 5 mls of water; therefore, the MDC for these samples was higher.

Filters from the molecular sieve columns were analyzed by gamma spectroscopy for gamma-emitting particulates. For most gamma-emitters the minimum detectable activity is approximately 100 pCi.

Snow samples were melted and the resulting water was analyzed in the same manner as the water from the molecular sieve.

Vegetation and soil samples were analyzed for ^{3}H concentration by extracting the water and analyzing for tritium by liquid scintillation

counting. The counting procedures were the same as for water from the molecular sieve.

Glass fiber filters from the cryogenic sampler were analyzed by gamma spectroscopy to identify and quantitate gamma-emitting particulates. Water was removed and analyzed, as for the molecular sieve samples, for ^{3}H. The inert gas fraction was removed from the molecular sieve trap and separated by gas chromatography and cryogenic techniques. These separated fractions were analyzed for radioactive isotopes of krypton and xenon. With a minimum detectable activity of about 100 pCi and an average sample volume of 3 cubic meters, the MDC is about 35 pCi/m^3 of air.

Carbon dioxide removed from cryogenic and molecular sieve samples was separated from the other gases. Aliquots of CO_2 were dissolved in hydroxide of Hyamine (10-X) and counted for ^{14}C by liquid scintillation techniques. The MDC for ^{14}C is 0.02 pCi/ml of CO_2. With a CO_2 concentration of 0.03% in the atmosphere, the MDC for CO_2 in the atmosphere is 6 pCi/m^3.

DISCUSSION OF SAMPLING CONDITIONS

November 1968

Seven air samples were taken on November 5-6, 1968, including four background samples. The latter were taken at distances ranging from approximately 18 miles to 55 miles from the Gasbuggy site. Two of the three samples taken near surface ground zero (SGZ) were taken downwind during daytime hours (air temperature 46°F). The surface wind direction varied but was generally from the northeast quadrant with an estimated velocity of 5 to 10 mph. The third sample was taken downwind at night during a drainage condition (air temperature 21°F, surface wind estimated velocity of 0 to 2 mph). During a drainage condition the winds blow northwest through La Jara Canyon. The flaring rate of natural gas from the GB-ER well during the period was 3500 MCFD. (MCFD refers to a standard flow unit of 1,000 cubic feet per day.)

December 1968

Five air samples were taken on December 13, 1968, at three locations near SGZ. The first four samples were taken 0.3 mile and 1.3 miles northwest of SGZ. Two samples were taken at each location; the first was taken during normal flaring of chimney gas; the second set while previously collected liquid condensate was being vaporized in the flare. Surface wind conditions during collection of these samples were "light and variable" with air temperatures ranging from 32 to 35°F. The fifth sample was collected 0.5 mile northeast of SGZ. The wind was from the south-southeast during the collection period of the fifth sample. The flaring rate of natural gas from GB-ER during the day was 600 MCFD.

January 1969

Six air and six snow samples were taken on January 14, 1969. The winds were "light and variable" and appeared to vary from the northwest, through the southwest to the southeast. The air temperature was about 45°F. Four sampling locations were selected to cover as much of the apparent direction of movement as possible; however, melting snow and deep mud prevented sampling to the northeast. One air sample and two snow samples were taken while a light-to-moderate rain was falling. The most recent snow fall was on December 27, 1968. Gas was flowing at 4750 MCFD and previously collected liquid condensate was being vaporized in the flare. Production testing was shut down from 1200 to 1400 hours.

February 1969

Six air samples and six snow samples were taken on February 13, 1969. The surface wind conditions were "light and variable" with the winds from northwest through southwest to southeast. Two air sampling locations, both 0.3 mile from SGZ were used within the downwind sector. Approximately four inches of snow had fallen during the previous night. Snow samples were taken at the same two locations and four other locations at varying distances in the direction of nighttime drainage wind flow. The gas flow rate was 460 MCFD.

March 1969

Six air samples were taken on March 27, 1969. The surface winds were "light and variable" with no discernible predominant direction; therefore, three sampling locations, surrounding SGZ were selected; each was 0.3 mile from SGZ. During the sampling period liquid condensate, which had been collected previously, was discharged into the flare. The flaring rate was 450 MCFD.

May 1969

The collection techniques were modified in May to provide greater field mobility. Six of the twelve May samples were taken simultaneously on the night of May 19. The locations, ranging from 0.7 to 2.0 miles from SGZ, were selected along the path of the drainage winds. At a distance of 1.2 miles two samples were taken on each side of the valley through which the drainage winds pass. The two locations were approximately 0.1 mile apart. It is possible that a true drainage condition did not exist during the sampling period, since subjective evaluations indicated a slight cross-valley component. The winds were very light with occasional speeds of 2 mph, as measured with a portable wind-speed indicator.

The remaining May samples were taken the following day. The wind speed was light with occasional gusts to 8 mph; the direction varied, but was generally from the southwest quadrant. The six samples were taken simultaneously on an arc from north to south-southeast ranging from 0.7 to 2.2 miles from SGZ. The gas flow was 260 MCFD during both sampling periods.

July 1969

Eleven air samples were taken in July. Six of these samples were taken simultaneously on the night of July 16. The winds were calm; therefore, samples were taken around SGZ at distances ranging from 0.7 to 2.1 miles.

The remaining July samples were taken the following day. The surface wind was blowing from the east at speeds from 0 to 5 mph. The five samples were taken simultaneously on an arc from northwest to southwest at distances ranging from 1.0 to 2.0 miles from SGZ. The gas flow rate during both sampling periods was 160 MCFD.

August 1969

Eleven samples were taken during August 1969. Six of these samples were taken simultaneously on the afternoon of August 4. The surface wind was blowing from the west at speeds of 0 to 5 mph with occasional gusts to 10 mph. The samples were taken in the sector from northeast to southeast at distances from 1.0 to 2.4 miles from SGZ. There were light rain showers during the last half of the sampling period. The molecular sieve columns were inverted so no rain could enter directly into the column.

The remaining five samples were taken simultaneously during the night of August 4. The surface wind was blowing from the east-northeast at speeds from 0 to 3 mph. The samples were taken in the sector from northwest to southwest at distances from 1.1 to 2.0 miles from SGZ. The flaring rate during both sampling periods was 160 MCFD.

September 1969

Eleven samples were taken during September 1969. Three samples were taken during the early afternoon of September 25. Surface winds were blowing from the northeast at 0 to 5 mph. Balloons used to determine the wind direction indicated the same conditions aloft. Samples were taken southwest of SGZ at distances from 5 to 8 miles. Aerial samples were collected downwind from the flaring stack simultaneously with the ground samples. The aircraft cryogenic sampler collected an integrated sample from 8,000, 9,000, 10,000, and 11,000 feet mean sea level (MSL). Surface elevation at SGZ is about 7,200 feet MSL.

Three samples were taken during the early evening of September 25. The winds were from the west at speeds from 0 to 10 mph. Samples were taken east of SGZ at approximately 10 miles. During this sampling period the aircraft once again took a cryogenic sample downwind from the flaring stack at elevations of 8,000, 9,000, and 10,000 feet MSL.

The other five samples were collected at midnight September 25, 5 to 10 miles northwest of SGZ to monitor the drainage winds. These drainage winds developed in the lower levels of La Jara Canyon, but did not extend to the elevation of Gasbuggy. At SGZ the winds were blowing from the west at 0 to 10 mph. During these sampling periods the flaring rate was 175 MCFD.

October 1969

Fifteen samples were collected during October 1969. Seven samples were taken during the early afternoon of October 29, approximately 10 miles east of SGZ, while the flaring rate was 1714 MCFD. Winds were blowing from the west at speeds of 0 to 10 mph. A sample was collected on a large molecular sieve sampler and a small molecular sieve sampler at the same location for comparison. During this sampling period an aircraft took a cryogenic sample downwind of the stack.

The other eight samples were taken during the early afternoon of October 30. During this sampling period the flaring rate was 1640 MCFD and previously collected liquid condensate was being vaporized in the flare. The winds were "light and variable" with the general direction from the west. The samples were taken around SGZ at distances from 1 to 2.2 miles. Two large molecular sieve samplers were operated at the same locations as two small molecular sieve samplers. During the sampling period an aircraft took a cryogenic sample in the area with most of the sampling time spent to the east of SGZ.

DISCUSSION OF RESULTS

Air Samples

The air moisture sampling results are given in Appendix B. Close-in sampling sites are shown in Figure 1 and more distant stations in Figure 2. The ^{3}H background in atmospheric moisture is approximately 1.0 pCi/ml of H_2O. Because of the wide range of humidities encountered the amount of water in one cubic meter of air varied from two to fourteen mls. Because of this, the atmospheric ^{3}H background could vary from two to fourteen pCi/m^3 of air. Therefore, the ^{3}H concentration in atmospheric moisture was used to determine if a sample exceeded background. The existing radiation protection standard* for ^{3}H in air is an exposure of 6.7×10^4 pCi/m^3 to a suitable sample of an uncontrolled population. For the range of humidities encountered this would require ^{3}H concentrations of 5×10^3 to 3×10^4 pCi/ml in atmospheric moisture. Tritium activities greater than 1.0 pCi/ml were measured in 31 of the 86 samples collected. The two highest ^{3}H activities were found at the beginning of production testing in November 1968. The highest concentration measured was less than one percent of the radiation protection standard.

In all cases where two samples were collected on the same azimuth and at the same time, but at different distances, the water recovered from the closer sample contained a higher concentration of ^{3}H. This decrease in concentration with distance is as expected for a surface release.

September and October were the only months in which an attempt was made to sample as far away as ten miles. The more distant samples were only slightly above background when positive.

The maximum detected ^{14}C level, 18 pCi/m^3 of air, was only three times normal background. The Radioactivity Concentration Guide for ^{14}C is 3.3×10^4 pCi/m^3.

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*AEC Manual Chapter 0524.

The beta counts and gamma scans of the glass fiber filters used at the inlet of the molecular sieve columns were all negative for fission products. For the large columns the MDC for a one-hour sample was approximately 10 pCi/m^3 for gamma-emitting nuclides and 1 pCi/m^3 for gross beta. For the small columns the MDC for a one-hour sample was 100 pCi/m^3 for gamma-emitters and 10 pCi/m^3 for gross beta.

The results for aerial samples are given in Appendix C. In September only ^{3}H was identified. More ^{85}Kr than ^{3}H was collected on the cryogenic samples in October; however, the on-line monitor showed a higher level of ^{3}H than ^{85}Kr in the product gas.

Snow Samples

The results from the tritium analysis of snow samples are given in Appendix D and stations are shown on Figure 3. None of these samples had a tritium concentration which could be positively identified as above background levels.

Vegetation

Vegetation samples were collected November 6, 1968, July 17, 1969, and October 29-30, 1969, from the stations located on Figure 4. Appendix E presents the results of tritium analysis of these samples. The tritium concentration in pCi/ml of water removed from the vegetation is listed, and is the value which should be compared to the corresponding value for soil from the same location. The moisture ratio, R*, allows one to calculate the ^{3}H in fresh tissue. The standard deviations shown are based on the variability between a number of individual samples collected at each station.

Gamma analysis of the vegetation samples showed no evidence of greater contamination by gamma emitters than occurs in other areas due to

*R = (grams H_2O/grams of dry tissue) x 100.

worldwide fallout. Concentrations of ^{3}H in water removed from all November 1968 vegetation samples were above background. The highest levels occurred in the November 1968 samples. The maximum seen was 36 pCi/ml of water or 21 pCi/gram of dry tissue. In all cases, except one, the ^{3}H activities per ml of water decreased from November 1968 to July 1969 for the six stations sampled both times. The one station which showed an increase was in the direction of nighttime drainage winds. This station was also at the normal background tritium level when sampled in October. The maximum concentration measured in the July samples was 8.4 pCi/ml of recovered water, or 6.8 pCi/gram of dry tissue. In several cases, because of the insignificant change in ^{3}H per ml of water and the large increase in moisture content, the ^{3}H in water from one gram of tissue increased. Tritium concentrations in all October samples were in the range of normal background.

Soil

Soil samples were collected November 6, 1968, and July 17, October 29-30, and November 2-8, 1969. Sample results are presented in Appendix F in the same form as vegetation data in Appendix E, except that percent moisture is reported in place of R. The main emphasis in analysis was placed on ^{3}H. However, several samples were analyzed by gamma spectrometry. Small amounts of ^{137}Cs were observed in these samples in concentrations similar to those found in the vicinity of Las Vegas, Nevada, due to worldwide fallout.

Tritium concentrations in moisture from two of the six November 1968 samples were above background. Although the tritium concentrations found in the July 1969 samples were at or slightly above normal concentrations found in atmospheric moisture, they were higher than the concentrations found in October and November. This could indicate the presence of tritium from production testing of Gasbuggy or might be the result of recent rainfall. All October and November 1969 samples contained only background levels of ^{3}H.

A definite correlation was found to exist between tritium concentrations in soil moisture and in plant moisture. At those locations where tritium concentrations above background were found in both plant and soil water, the concentrations in plant moisture were three to five times the concentrations in soil moisture collected at the same location.

IMPLICATIONS OF OTHER SURVEILLANCE

The routine SWRHL surveillance networks that collected samples in the general area of Project Gasbuggy showed no increase in the levels of radioactivity during the production tests.

Results from the SWRHL Air Surveillance Network (ASN) are shown in Appendix G. Albuquerque, New Mexico, and Durango, Colorado, were the two ASN stations nearest the Gasbuggy site. Eight surrounding ASN stations were selected as an ASN sample to compare with Albuquerque and Durango. These eight stations were Monticello, Utah; Winslow, Arizona; Amarillo, Abilene, and Fort Worth, Texas; Carlsbad, New Mexico; Muskogee, Oklahoma; and Dodge City, Kansas. Table G-1 shows the monthly average of detected gross beta levels in air for Albuquerque and Durango compared to the average of the ASN sample stations. Table G-2 shows the maximum, minimum, and average detected gross beta concentrations for Durango and Table G-3 shows the same for Albuquerque. These results show that there was no significant rise of radiation levels in the general Gasbuggy area above the levels at surrounding stations. The high gross beta concentrations in the tables were identified, by the use of isotopic analysis, as being from Project Schooner[6], the Pewee EP-III reactor engine test[7], and worldwide fallout. No fission products were identified on any of the ASN filters in this area except those related to the above mentioned events.

Results from the Pasteurized Milk Network are shown in Appendix H. The two stations in this network that were nearest the Gasbuggy site were Denver, Colorado, and Albuquerque, New Mexico. The concentrations of ^{90}Sr, ^{131}I, and ^{137}Cs are shown for Denver, Albuquerque, and the total network. These are presented as averages for one-month periods and the previous

twelve-month periods. The levels of activity for Denver and Albuquerque are lower than those for the rest of the network, indicating that there is no contribution of these isotopes from Gasbuggy.

The tritium levels in surface and well water from New Mexico and Colorado are shown in Appendix I, Tables 1 and 2, respectively. The levels of tritium in the water collected nearer the Gasbuggy site were no higher than the levels in the same type of supply (well or surface) collected at a greater distance from the site.

SUMMARY

Environmental samples collected within ten miles of Gasbuggy contained ^{3}H released during production testing. Several samples had ^{14}C concentrations up to three times background. Except for ^{85}Kr in two aerial air samples, no contamination by other isotopes was detected.

Tritium levels in atmospheric moisture were highest in November 1968. After the middle of 1969 only occasional samples were positive and these were less than ten times normal background. The highest concentration of ^{3}H in an air sample was 0.9% of the radiation protection standard for continuous exposure to a suitable sample of an uncontrolled population.

Soil and vegetation samples exhibited the maximum ^{3}H concentrations in November 1968 with several positive, but lower concentrations found in July 1969. By October 1969, all samples collected were at background.

Investigation of other sampling networks revealed no evidence of Gasbuggy-related radioactivity beyond the immediate environs of the test area.

CONCLUSION

It is concluded from the results of this surveillance that production testing of the Gasbuggy re-entry well resulted in environmental concentrations of radionuclides well below the radiation protection standards of AEC Manual Chapter 0524.

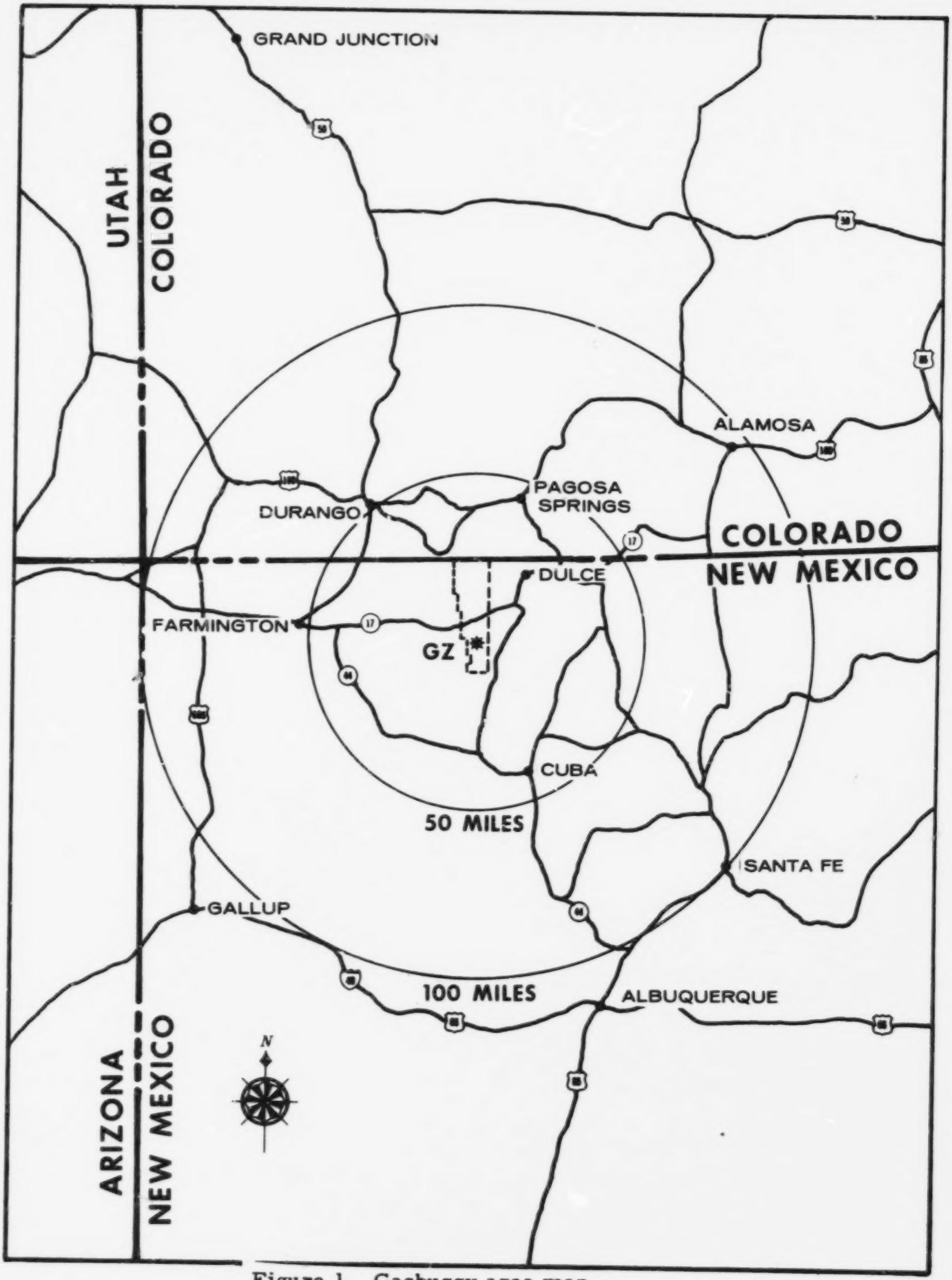

Figure 1. Gasbuggy area map.

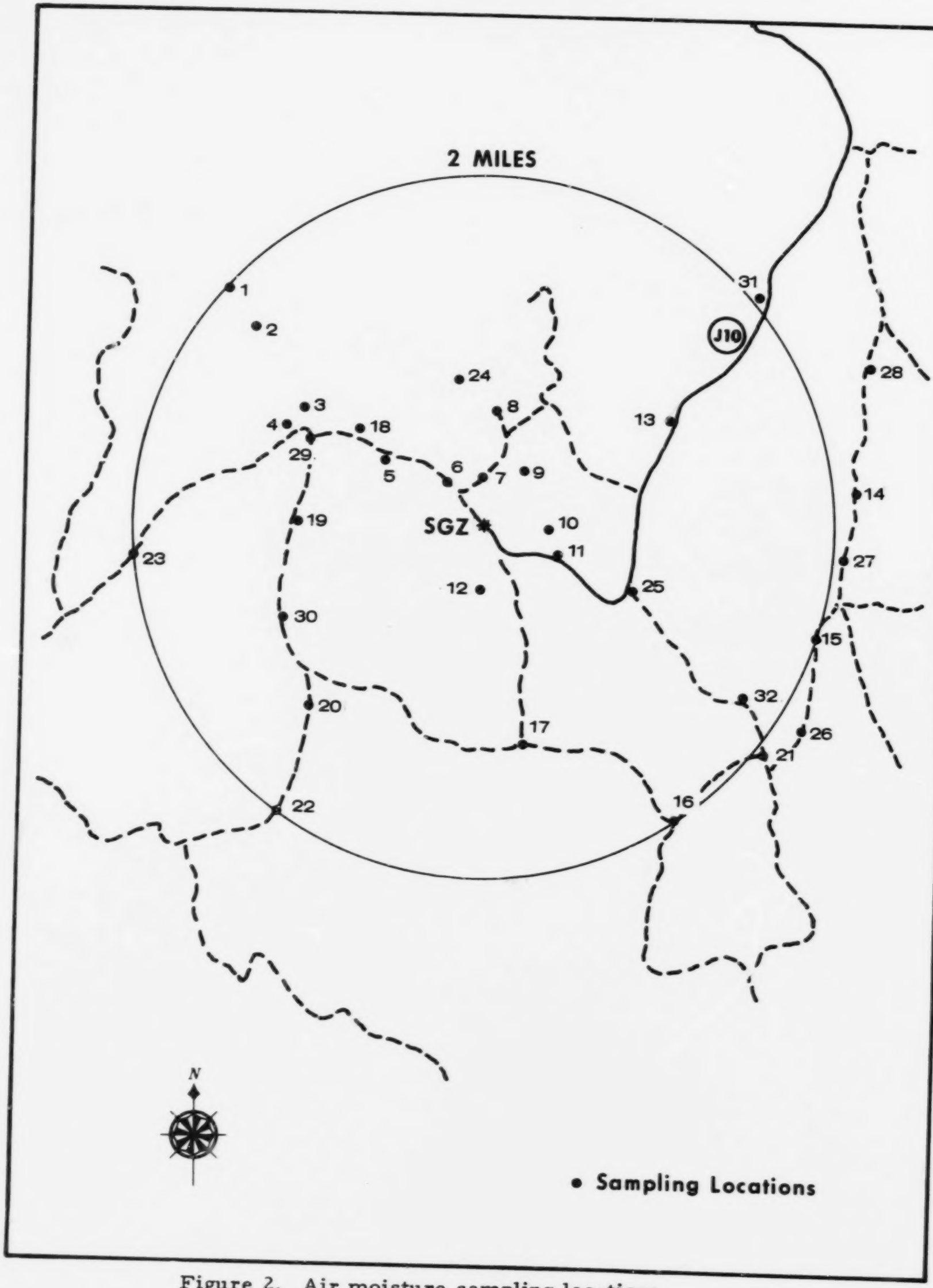

Figure 2. Air moisture sampling locations.

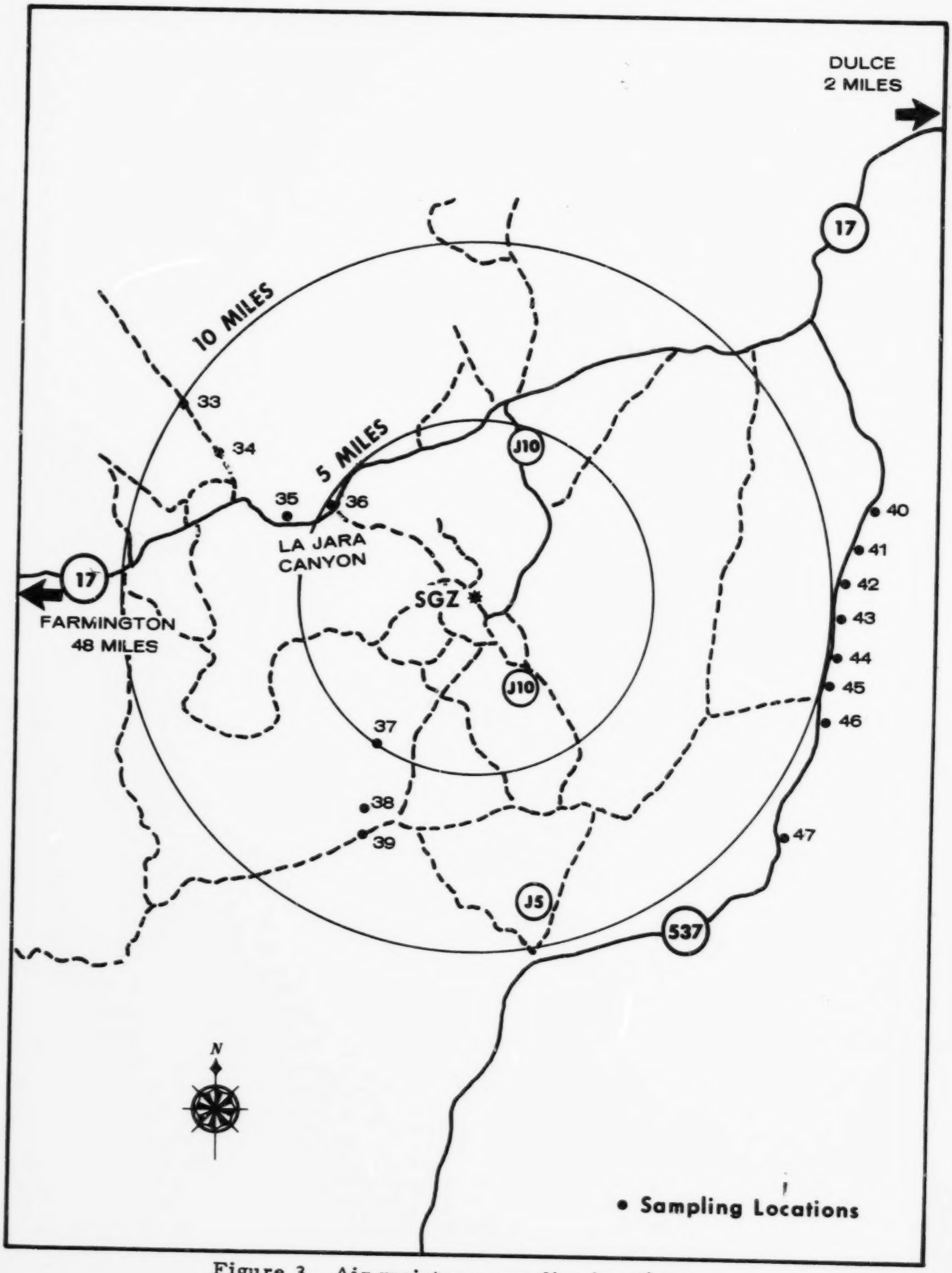

Figure 3. Air moisture sampling locations.

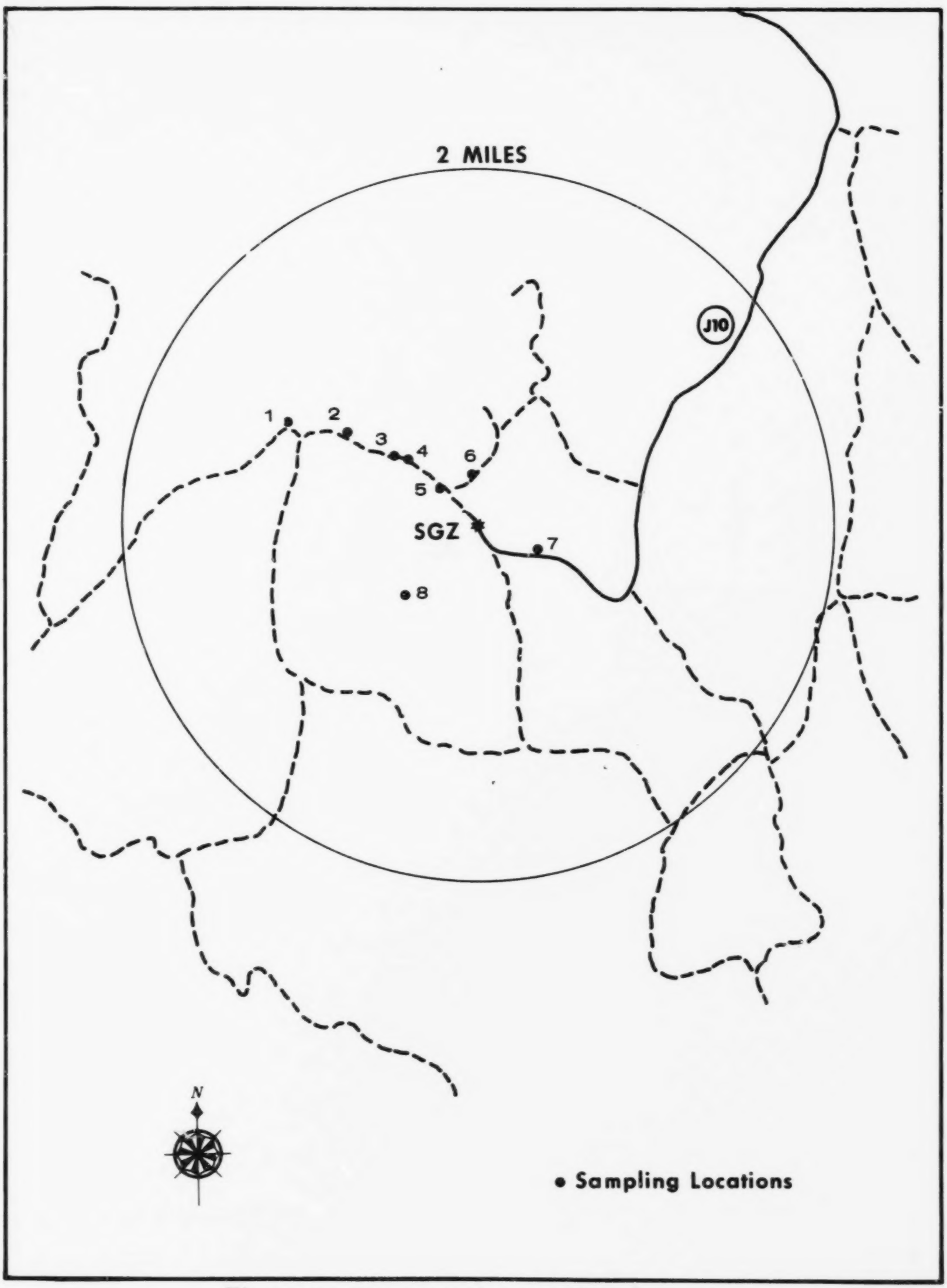

Figure 4. Snow sampling locations.

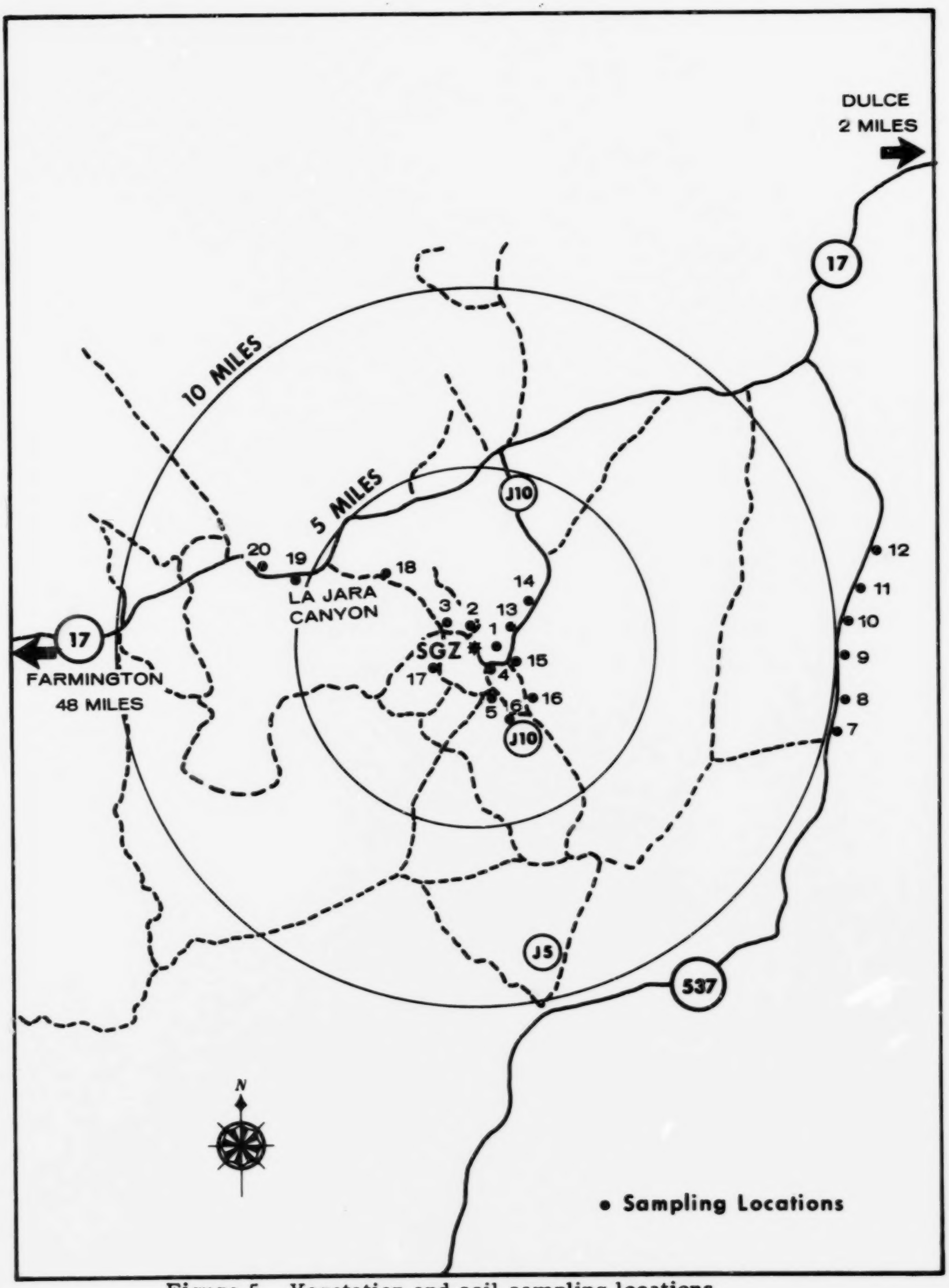

Figure 5. Vegetation and soil sampling locations.

REFERENCES

1. Report of Off-Site Surveillance for Project Gasbuggy, March 1967 - June 1968, Environmental Surveillance, Southwestern Radiological Health Laboratory. February 1970. SWRHL-99r.

2. Hill, Dixon H., and McBride, John R. Off-Site Radiological Surveillance Program for Project Gasbuggy. Radiological Health Data and Reports, Vol. 10, No. 12, pp 535-546. December 1969.

3. Project Gasbuggy Off-Site Radiological Safety Report GB-2R Phase I Program. Southwestern Radiological Health Laboratory. November 1968.

4. Project Gasbuggy Off-Site Radiological Safety Report, Supplementary Appendices. Unpublished.

5. Handbook of Radiochemical Analytical Methods. Southwestern Radiological Health Laboratory. February 1970. SWRHL-11.

6. Off-Site Surveillance - Schooner Event. Southwestern Radiological Health Laboratory. To be published.

7. Final Report of Off-Site Surveillance for Pewee I Experimental Plans II and III. SWRHL-87r. Southwestern Radiological Health Laboratory. To be published.

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APPENDIX A

Population Within 25 Miles of Surface Ground Zero
(Revised 10-18-67)

SECTOR (°)	DISTANCE - 0-5 (mi)	5-10	10-15	15-20	20-25
0-15	0	5	0	0	18
15-30	0	0	3	0	4
30-45	0	4	0	70	2210
45-60	0	8	10	8	84
60-75	0	0	10	0	0
75-90	0	0	0	0	3
90-105	0	0	0	8	0
105-120	0	0	5	0	10
120-135	0	0	1	0	0
135-150	0	2	2	14	10
150-165	0	0	0	9	40
165-180	0	0	7	19	15
180-195	0	0	3*	0*	8*
195-210	0	0	0*	0*	0*
210-225	0	0	2*	0*	17
225-240	0	2	0	98	62
240-255	0	0	2	5	2
255-270	0	0	7	0	0
270-285	0	125	9	3	2
285-300	0	0	6	0	6
300-315	0	0	0	0	0
315-330	0	0	0	0	0
330-345	0	0	0	0	0
345-360	0	3	0	0	18

Population figures include Census Supplement (10-18-67) figures.

*Wintering area for sheep - several herders will winter in this area.

APPENDIX B

Air Samples
Gasbuggy Area

LOCATION NO. ON FIGURE 2 OR FIGURE 3	DISTANCE AND DIRECTION FROM SGZ	DATE COLLECTED	TIME OF MID-POINT OF COLLECTION	TRITIUM* CONCENTRATION (pCi/ml of H_2O)	TRITIUM* CONCENTRATION (pCi/ambient m^3 of air)
Background	Negeezi, New Mexico	11-5-68	2000	<0.4	-----
Background	Farmington, New Mexico	11-6-68	1630	<0.4	-----
Background	Jct. of Highway 537 and Ojito Road	11-6-68	1100	1.0±0.3	4.3±1.3
Background	Dulce, New Mexico	11-6-68	1400	<0.4	-----
7	0.3 mi N	11-5-68	2000	1.5±0.4	5.8±1.5
10	0.3 mi E	11-6-68	1000	116 ±1.5	500 ±6.5
10	0.3 mi E	11-6-68	1200	75 ±1.2	320 ±5.1
6	0.3 mi NW	12-13-68	1130	11 ±0.6	24 ±1.4
6	0.3 mi NW	12-13-68	1330	4.4±0.8	9.7±1.7
4	1.3 mi NW	12-13-68	1200	1.6±0.6	3.0±1.1
4	1.3 mi NW	12-13-68	1400	2.5±0.6	4.0±1.0
9	0.5 mi NNE	12-13-68	1600	2.5±0.7	11 ±3.2
6	0.3 mi NW	1-14-69	1000	1.6±0.9	8.8±4.7
7	0.3 mi N	1-14-69	1130	1.1±0.3	5.8±1.8
7	0.3 mi N	1-14-69	1230	2.3±0.4	13 ±2.1
7	0.3 mi N	1-14-69	1445	<0.4	-----
11	0.3 mi ESE	1-14-69	1030	0.5±0.3	2.7±1.8
12	0.3 mi SW	1-14-69	1200	<0.4	-----
11	0.3 mi ESE	2-13-69	0915	1.0±0.4	6.4±2.5

*Probable errors shown are at 95% confidence level, based on counting statistics.

APPENDIX B (cont)

LOCATION NO. ON FIGURE 2 OR FIGURE 3	DISTANCE AND DIRECTION FROM SGZ	DATE COLLECTED	TIME OF MID-POINT OF COLLECTION	TRITIUM CONCENTRATION (pCi/ml of H_2O)	TRITIUM CONCENTRATION (pCi/ambient m^3 of air)
11	0.3 mi ESE	2-13-69	1030	1.8±0.4	9.8±2.2
11	0.3 mi ESE	2-13-69	1200	3.6±0.4	23 ±2.6
7	0.3 mi N	2-13-69	0945	8.5±0.5	53 ±3.1
7	0.3 mi N	2-13-69	1045	2.9±0.4	14 ±1.9
7	0.3 mi N	2-13-69	1200	2.0±0.4	16 ±3.2
7	0.3 mi N	3-27-69	0915	8.6±1.3	21 ±3.2
7	0.3 mi N	3-27-69	1015	3.1±0.4	7.2±1.0
7	0.3 mi N	3-27-69	1115	3.3±0.4	8.1±1.0
12	0.3 mi SW	3-27-69	0930	3.2±0.4	10 ±1.3
12	0.3 mi SW	3-27-69	1015	0.75±0.35	3.8±1.7
11	0.3 mi ESE	3-27-69	1130	7.1±0.5	14 ±1.0
5	0.7 mi NW	5-19-69	2200	<1.5*	-----
4	1.2 mi NW	5-19-69	2200	<1.5	-----
18	0.9 mi NW	5-19-69	2200	3.0±2.2	13 ±9.7
3	1.2 mi NW	5-19-69	2200	<1.7	-----
2	1.7 mi NW	5-19-69	2200	<1.5	-----
1	2.0 mi NW	5-19-69	2200	<2.0	-----
8	0.7 mi N	5-20-69	1210	20 ±2.1	83 ±8.8
13	1.3 mi ENE	5-20-69	1210	<1.4	-----
14	2.2 mi E	5-20-69	1210	<1.8	-----

*Samples from which less than five mls of H_2O were recovered have minimum detectable activities greater than 0.4 pCi/ml.

APPENDIX B (cont)

LOCATION NO. ON FIGURE 2 OR FIGURE 3	DISTANCE AND DIRECTION FROM SGZ	DATE COLLECTED	TIME OF MID-POINT OF COLLECTION	TRITIUM CONCENTRATION (pCi/ml of H_2O)	TRITIUM CONCENTRATION (pCi/ambient m^3 of air)
15	2.0 mi ESE	5-20-69	1210	<2.0	-----
16	2.0 mi SE	5-20-69	1210	<1.9	-----
17	1.2 mi SSE	5-20-69	1210	<2.1	-----
5	0.7 mi NW	7-16-69	2330	1.1±0.5	14 ±6.4
19	1.1 mi W	7-16-69	2340	<0.4	-----
20	1.2 mi SW	7-16-69	2355	<0.4	-----
13	1.3 mi ENE	7-16-69	2330	0.8±0.5	11 ±7.2
21	2.1 mi SE	7-16-69	2330	0.5±0.5	7.0±7.0
17	1.2 mi SSE	7-16-69	2345	0.6±0.5	8.2±6.8
22	2.0 mi SW	7-17-69	1325	<0.4	-----
23	2.0 mi W	7-17-69	1335	<0.4	-----
19	1.1 mi W	7-17-69	1305	0.7±0.5	6.5±4.6
3	1.2 mi NW	7-17-69	1335	<0.4	-----
24	1.0 mi NNW	7-17-69	1315	<0.4	-----
25	1.0 mi ESE	8-4-69	1720	<0.5	-----
13	1.3 mi ENE	8-4-69	1730	0.9±0.4	10 ±4.5
16	2.0 mi SE	8-4-69	1730	0.7±0.4	6.7±3.9
26	2.2 mi ESE	8-4-69	1745	0.7±0.4	8.6±4.9
27	2.1 mi E	8-4-69	1720	0.7±0.4	8.1±4.7
28	2.4 mi ENE	8-4-69	1735	0.9±0.5	9.9±5.5

APPENDIX B (cont)

LOCATION NO. ON FIGURE 2 OR FIGURE 3	DISTANCE AND DIRECTION FROM SGZ	DATE COLLECTED	TIME OF MID-POINT OF COLLECTION	TRITIUM CONCENTRATION (pCi/ml of H_2O)	TRITIUM CONCENTRATION (pCi/ambient m^3 of air)
3	1.2 mi NW	8-4-69	2240	0.7±0.3	9.3±3.9
19	1.1 mi W	8-4-69	2240	1.0±0.5	14 ±7.2
20	1.2 mi SW	8-4-69	2240	0.6±0.3	10 ±5.3
22	2.0 mi SW	8-4-69	2300	0.9±0.3	11 ±3.7
23	2.0 mi W	8-4-69	2305	0.9±0.4	11 ±4.7
37	5.0 mi SW	9-25-69	1300	<2.5	-----
38	7.0 mi SW	9-25-69	1305	<0.4	-----
39	8.0 mi SSW	9-25-69	1315	<1.1	-----
43	10.1 mi E	9-25-69	1744	<2.7	-----
46	10.5 mi ESE	9-25-69	1750	4.0	13
47	11.0 mi SE	9-25-69	1753	<1.7	-----
36	5.0 mi WNW	9-25-69	2330	<11	-----
35	5.8 mi WNW	9-25-69	2340	<1.5	-----
34	8.5 mi WNW	9-25-69	2400	<1.1	-----
33	10.0 mi WNW	9-25-69	2400	<1.6	-----
40	11.3 mi ENE	10-29-69	1345	4.3	17
41	10.7 mi E	10-29-69	1340	0.9	3.0
42	10.3 mi E	10-29-69	1330	<1.4	----
43	10.1 mi E	10-29-69	1325	<0.8	----

APPENDIX B (cont)

LOCATION NO. ON FIGURE 2 OR FIGURE 3	DISTANCE AND DIRECTION FROM SGZ	DATE COLLECTED	TIME OF MID-POINT OF COLLECTION	TRITIUM CONCENTRATION (pCi/ml of H_2O)	TRITIUM CONCENTRATION (pCi/ambient m^3 of air)
43*	10.1 mi E	10-29-69	1330	2.0	3.6
44	10.3 mi E	10-29-69	1345	<0.6	----
45	10.2 mi E	10-29-69	1355	7.5	35
13	1.3 mi ENE	10-30-69	1310	<7.4	----
25	1.0 mi ESE	10-30-69	1305	1.7	5.4
29	1.1 mi WNW	10-30-69	1335	<0.4	----
29*	1.1 mi WNW	10-30-69	1335	1.1	2.4
30	1.2 mi WSW	10-30-69	1346	<0.8	----
30*	1.2 mi WSW	10-30-69	1355	<0.4	----
31	2.1 mi NE	10-30-69	1315	2.4	11
32	1.7 mi ESE	10-30-69	1325	Lost	----

*Large molecular sieve sampler.

APPENDIX C

Aerial Cryogenic Samples

LOCATION	DATE	TIME (PST)	TRITIUM (pCi/m^3)	KRYPTON** (pCi/m^3)	XENON (pCi/m^3)
SW of SGZ 1/4 at 8,000 ft MSL* 1/4 at 9,000 ft MSL 1/4 at 10,000 ft MSL 1/4 at 11,000 ft MSL	9-25-69	1300	17	<35	<35
E of SGZ 1/2 at 9,000 ft MSL 1/4 at 8,000 ft MSL 1/4 at 10.000 ft MSL	9-25-69	1700	14	<35	<35
E of SGZ 1/2 at 8,000 ft MSL 1/2 at 7,500 ft MSL	10-29-69	1300	10	450	<35
E of SGZ At 8,000 ft MSL	10-30-69	1305	15	350	<35

*Fraction of sample collected at altitude shown.

**Gross analysis was performed for radioisotopes of krypton and xenon. All krypton detected was assumed to be ^{85}Kr.

APPENDIX D

Snow Samples
Gasbuggy Area

MAP* LOCATION NO.	LOCATION	DATE	TIME	^{3}H CONCENTRATION (pCi/ml H_2O)**
5	0.3 mi NW	1-14-69	1315	1.1±0.34
6	0.3 mi N	1-14-69	1050	1.1±0.34
7	0.3 mi ESE	1-14-69	1100	2.1±0.37
8	0.5 mi SW	1-14-69	1130	1.0±0.34
4	0.5 mi NW	1-14-69	1445	0.66±0.33
1	1.3 mi NW	1-14-69	1450	0.85±0.34
7	0.3 mi ESE	2-13-69***	0945	0.9±0.4
6	0.3 mi N	2-13-69	0930	2.2±0.4
5	0.3 mi NW	2-13-69	1030	0.8±0.3
3	0.6 mi NW	2-13-69	1035	0.7±0.3
2	0.9 mi NW	2-13-69	1040	0.8±0.3
1	1.3 mi NW	2-13-69	1045	0.6±0.3

* See Figure 4

** Counting error based on 2σ; Detectable limit 0.4 pCi/ml of H_2O

***2 to 3 inches of snow had fallen the previous night

APPENDIX E

Results of Tritium Analysis of Vegetation Samples Collected for Project Gasbuggy

STATION	DISTANCE TO SGZ (mi)	DATE	pCi/ml of H_2O	R*	pCi/gm of DRY TISSUE**
1	0.5	11-6-68	36 ±9.4	61±13	21 ±4.7
		7-17-69	5.0±2.5	74±13	3.6±1.7
2	0.4	11-6-68	5.5±2.2	53±14	3.0±1.8
		7-17-69	5.3±2.3	78±10	4.1±1.9
3	1.2	11-6-68	4.1±1.4	53±19	2.1±1.0
		7-17-69	8.4±3.1	110±20	6.8±3.1
		10-30-69	0.8±0.2	149±83	1.1±0.3
4	0.3	11-6-68	15 ±4.5	71±14	10 ±3.5
		7-17-69	3.7±1.7	103±11	3.8±1.9
5	1.3	11-6-68	4.4±1.7	69±13	2.9±1.0
		7-17-69	3.7±1.2	105±28	3.8±1.7
6	2.2	11-6-68	5.0±2.5	71±14	3.5±1.6
		7-17-69	3.4±1.7	109±41	3.8±3.1
7	10.2	10-29-69	0.8±0.3	112±5.2	1.0±0.3
8	10.3	10-29-69	0.8±0.3	111±13	0.8±0.3
9	10.1	10-29-69	<0.60	120±6.5	<0.72
10	10.3	10-29-69	0.9±0.1	98±8	0.9±0.2
11	10.7	10-29-69	1.0±0.4	129±33	1.3±0.7
12	11.3	10-29-69	0.7±0.2	150±18	1.1±0.4
13	1.3	10-30-69	1.1±0.5	88±19	1.0±0.3
14	2.1	10-30-69	0.8±0.2	83±3.5	0.7±0.2
15	1.0	10-30-69	0.6±0.0	149±15	0.9±0.1
16	1.7	10-30-69	0.8±0.2	130±22	1.0±0.4
17	1.2	10-30-69	1.3±0.4	87±8	1.1±0.4

*R = (gram H_2O/gram dry tissue) x 100.

**Determined on a dry weight basis as the product of pCi/ml x R. Vegetation pCi/ml and R were rounded off after multiplication, so that small differences may exist between values in this column and the product of the rounded-off numbers in the other two columns.

APPENDIX F

Results of Tritium Analysis of Soil Samples Collected for Project Gasbuggy

STATION	DISTANCE TO SGZ (mi)	DATE	pCi/ml of H_2O	% MOISTURE	pCi/g ($\times 10^{-1}$)
1	0.5	11-6-68	7.1±1.9*	8.8±3.6	5.9 ±1.5
		7-17-69	1.6±0.5	3.6±1.0	0.58±0.26
2	0.4	11-6-68	<0.75	13 ±3.8	<0.9
		7-17-69	2.0±0.3	3.7±1.1	0.73±0.24
3	1.2	11-6-68	1.2±0.2	8.0±1.9	0.9 ±0.1
		7-17-69	1.2±0.3	3.6±0.2	0.43±0.09
		10-30-69	0.6	23.4	0.2
		11-4-69	<0.4	17.4	<0.1
4	0.3	11-6-68	3.7±0.6	4.5±0.3	1.6 ±0.3
		7-17-69	1.2±0.4	2.8±0.1	0.03±0.10
5	1.3	11-6-68	<0.75	4.2±0.6	<0.3
		7-17-69	1.1±0.2	1.4±0.1	0.16±0.04
6	2.2	11-6-68	<0.75	6.8±1.7	<0.5
		7-17-69	0.9±0.5	4.2±1.2	0.35±0.22
7	10.2	10-29-69	<0.6	24.8	<0.2
8	10.3	10-29-69	<0.6	24.1	<0.2
9	10.1	10-29-69	<0.6	22.3	<0.2
10	10.3	10-29-69	0.8	23.9	0.2
11	10.7	10-29-69	0.6	23.1	0.2
12	11.3	10-29-69	<0.6	15.7	<0.1
13	1.3	10-30-69	<0.6	15.4	<0.1
14	2.1	10-30-69	<0.6	15.9	<0.1
15	1.0	10-30-69	1.2	28.6	0.3
16	1.7	10-30-69	<0.6	20.2	<0.1
17	1.2	10-30-69	<0.6	15.6	<0.1
18	5.0	11-4-69	<0.4	27.2	<0.1
19	6.0	11-5-69	<0.4	12.2	<0.1
20	7.0	11-5-69	<0.4	9.8	<0.1

*All standard deviations shown are based on the results of several samples collected at each location. In October and November 1969 only one sample was collected at each location.

APPENDIX G
TABLE 1

Air Gross Beta - Monthly Averages
November 1968 through October 1969

MONTH	ALBUQUERQUE		DURANGO		ASN SAMPLE	
	NUMBER OF SAMPLES ABOVE DETECTABLE LIMIT*	AVERAGE CONCENTRATION (pCi/m^3)	NUMBER OF SAMPLES ABOVE DETECTABLE LIMIT*	AVERAGE CONCENTRATION (pCi/m^3)	NUMBER OF SAMPLES ABOVE DETECTABLE LIMIT*	AVERAGE CONCENTRATION (pCi/m^3)
November 1968	3	0.1	1	0.2	19	0.2
December 1968	16	3.9**	14	8.9**	110	1.9**
	13	0.6***	9	0.5***	92	0.3***
January 1969	13	0.2	9	0.3	66	0.3
February 1969	17	0.3	14	0.3	98	0.2
March 1969	16	0.3	20	0.3	103	0.2
April 1969	28	0.5	29	0.6	189	0.5
May 1969	28	0.7	31	0.8	222	0.7
June 1969	28	1.0	30	1.1	225	0.8
July 1969	26	0.4	27	0.4	195	0.6
August 1969	11	0.3	16	0.3	174	0.4
September 1969	11	0.3	12	0.3	126	0.3
October 1969	20	0.4	5	0.4	148	0.3

*Detectable limit is the activity such that the probable error is less than ±25% at the 95% confidence level.
**Results include Pewee and Schooner activity and samples.
***Results without Pewee and Schooner activity and samples.

APPENDIX G
TABLE 2

Durango Air Results
November 1968 through October 1969

MONTH	NUMBER OF SAMPLES ABOVE DETECTABLE LIMIT	MINIMUM DETECTED* CONCENTRATION GROSS BETA (pCi/m^3)	MAXIMUM DETECTED CONCENTRATION GROSS BETA (pCi/m^3)	AVERAGE DETECTED CONCENTRATION GROSS BETA (pCi/m^3)
November 1968	1	0.2	0.2	0.2
December 1968	14	0.2	92**	8.9
	9	0.2	1.7***	0.5
January 1969	9	0.2	0.5	0.3
February 1969	14	0.2	0.5	0.3
March 1969	20	0.2	0.6	0.3
April 1969	29	0.2	1.4#	0.6
May 1969	31	0.5	1.7#	0.8
June 1969	30	0.6	2.1#	1.1
July 1969	27	0.2	0.8#	0.4
August 1969	16	0.2	0.5	0.3
September 1969	12	0.2	0.5	0.3
October 1969	5	0.2	0.7	0.4

*Detectable limit is the activity such that the probable error is less than ±25% at the 95% confidence level.
**Include Pewee EP-III and Schooner activity.
***Without Pewee EP-III and Schooner activity.
#Seasonal world-wide fallout.

APPENDIX G
TABLE 3

Albuquerque Air Results
November 1968 through October 1969

MONTH	NUMBER OF SAMPLES ABOVE DETECTABLE LIMIT	MINIMUM DETECTED* CONCENTRATION GROSS BETA (pCi/m^3)	MAXIMUM DETECTED CONCENTRATION GROSS BETA (pCi/m^3)	AVERAGE DETECTED CONCENTRATION GROSS BETA (pCi/m^3)
November 1968	3	0.1	0.2	0.1
December 1968	16	0.1	28**	3.9
	13	0.1	2.8***	0.6
January 1969	13	0.2	0.4	0.2
February 1969	17	0.2	0.8	0.3
March 1969	16	0.2	0.6	0.3
April 1969	28	0.2	0.9#	0.5
May 1969	28	0.3	1.3#	0.7
June 1969	28	0.4	1.9#	1.0
July 1969	26	0.1	0.7#	0.4
August 1969	11	0.2	0.5	0.3
September 1969	11	0.1	0.5	0.3
October 1969	20	0.1	1.2	0.4

*Detectable limit is the activity such that the probable error is less than ±25% at the 95% confidence level.
**Includes Pewee EP-III and Schooner activity.
***Without Pewee EP-III and Schooner activity.
#Seasonal world-wide fallout.

APPENDIX H

Radionuclides in Milk - Monthly Averages
November 1968 through October 1969

MONTH	STATION	MONTHLY AVERAGE* (pCi/l)			PREVIOUS 12-MONTH AVERAGE** (pCi/l)		
		^{90}Sr	^{131}I	^{137}Cs	^{90}Sr	^{131}I	^{137}Cs
November 1968	Total Net	8	0	10	9	0	12
	Denver	3	0	5	4	0	7
	Albuquerque	0	0	0	2	0	2
December 1968	Total Net	8	0	11	9	0	12
	Denver	7	0	0	5	0	6
	Albuquerque	0	0	5	2	0	2
January 1969	Total Net	8	0	9	9	0	12
	Denver	6	0	0	5	0	5
	Albuquerque	4	0	3	3	0	2
February 1969	Total Net	7	0	10	9	0	12
	Denver	5	0	0	5	0	5
	Albuquerque	0	0	0	3	0	2
March 1969	Total Net	7	0	9	9	0	11
	Denver	3	0	0	5	0	5
	Albuquerque	0	0	2	2	0	0
April 1969	Total Net	3	0	8	9	0	11
	Denver	4	0	0	4	0	4
	Albuquerque	4	0	0	2	0	2
May 1969	Total Net	8	0	8	8	0	11
	Denver	4	0	0	5	0	3
	Albuquerque	3	0	0	2	0	2
June 1969	Total Net						
	Denver	5	0	0			
	Albuquerque	2	0	2			
July 1969	Total Net						
	Denver	4	0	7			
	Albuquerque	3	0	0			
August 1969	Total Net						
	Denver	3	0	0			
	Albuquerque	0	0	0			
September 1969	Total Net						
	Denver	6	0	0			
	Albuquerque	2	0	3			
October 1969	Total Net						
	Denver	5	0	4			
	Albuquerque	2	0	0			

*Values shown are averages of weekly sample results and may be less than the minimum detectable concentration for a single sample.

**Data not available after May 1969.

APPENDIX I
TABLE 1

Tritium in Water (New Mexico)

LOCATION	DATE COLLECTED	^{3}H (pCi/l)
Carlsbad (Well)	10-9-68	<400
	1-10-69	<400
	4-8-69	<400
	7-22-69	<400
Clayton	10-15-68	<400
	1-16-69	<400
	7-29-69	<400
Clovis (Well)	10-9-68	<400
	1-10-69	<400
	4-4-69	<400
	7-19-69	<400
Espanola (Well)	10-3-68	<400
	1-10-69	<400
	4-4-69	<400
	7-22-69	<400
Farmington (Well)	10-7-68	1400
Farmington (Animas River)	1-10-69	900
	4-7-69	980
	8-15-69	660
Gallup (West Well Field)	10-4-68	<400
	1-10-69	<400
	4-9-69	<400
	7-23-69	<400
Hobbs	1-21-69	<400
	4-7-69	<400
	7-23-69	<400
Las Cruces (Rio Grande River)	10-7-68	450
	10-7-68	480
	1-20-69	<400
	4-7-69	780
	7-24-69	<400
Loving (10 mi SE of Carlsbad)	10-9-68	<400
Silver City	10-4-68	<400
	1-10-69	<400
	4-7-69	<400
	7-25-69	<400
Raton (64 mi Southwest Cimarron River)	4-4-69	1100

APPENDIX I
TABLE 2

Tritium in Water (Colorado)

LOCATION	DATE COLLECTED	^{3}H (pCi/l)
Boulder (Boulder Creek - 75th Avenue)	10-21-68	1700
	1-27-69	1700
	4-21-69	1600
	7-25-69	1700
Boulder (Boulder Creek - Eben Fine Park)	10-21-68	1200
	1-27-69	1600
	4-21-69	1300
	7-25-69	1500
Brighton (South Platte River)	10-14-68	1500
	1-20-69	1300
	4-28-69	970
	7-14-69	950
Colorado Springs (Fountain Creek upstream from Colorado Springs)	10-10-68	1700
	1-16-69	1100
	4-10-69	900
	7-9-69	1400
Colorado Springs (Fountain Creek downstream from Colorado Springs)	10-10-68	1000
	1-16-69	1100
	4-10-69	850
	7-9-69	950
Denver (South Platte River - Bowles Avenue)	10-14-68	1400
	1-20-69	<400
	4-28-69	1000
	7-14-69	1300
Greeley (Cache La Poudre River)	10-11-68	1800
	1-8-69	<400
	4-11-69	1500
	7-14-69	1400
Greeley (South Platte River at Highway 60)	10-11-68	2000
	1-8-69	2600
	4-11-69	1500
	7-14-69	1900
Greeley (South Platte River at Highway 66)	10-11-68	1800
	1-8-69	1400
	4-11-69	1300
	7-14-69	1300
Greeley (St. Vrain Creek at Highway 66)	10-11-68	2000
	1-8-69	1800
	4-11-69	1700
	7-14-69	1800